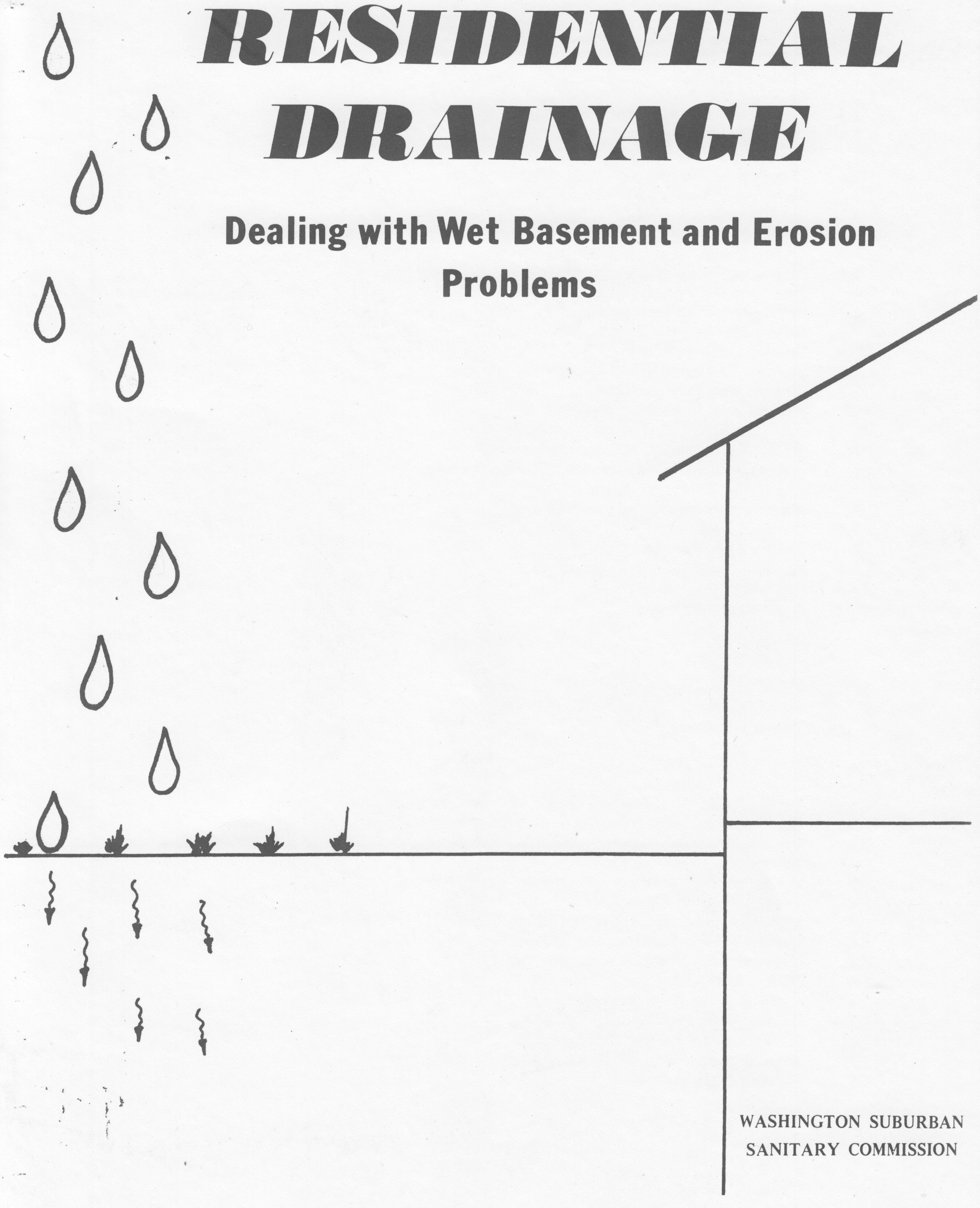
RESIDENTIAL DRAINAGE

Dealing with Wet Basement and Erosion Problems



WASHINGTON SUBURBAN
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RESIDENTIAL DRAINAGE

(Dealing With Basement and Erosion Problems)

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INTRODUCTION

This publication outlines several common measures that can be undertaken by the homeowner to correct wet basement and erosion problems. It also provides a basic description of the nature of these problems.

While we have endeavored to present acceptable remedial measures tailored for implementation by the homeowner, we recognize that many homeowners will be unable to undertake the work themselves and will seek the services of a contractor. For cases such as these, the information presented in this publication will familiarize the reader with a variety of basic corrective measures, making the homeowner aware of the options available.

We emphasize that the information and drawings presented are not intended to be applied without modification. They are illustrations provided to introduce some corrective options which are available and can be adapted to fit specific site conditions. A guide to governmental agencies and offices, which can be of further assistance on drainage control matters, is contained in Appendix A of this publication. Readers undertaking remedial measures described in the publication are encouraged to contact the appropriate governmental agencies in their areas to define permit requirements and to obtain any technical assistance or advice.

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1.0 Introduction to Basement Flooding Problems

It is estimated that 90% of all homes having cinder block basement walls will leak in the first 25 years of their life and one home in 300 have problems related to natural ground water tables. This section is intended to provide general information on methods currently available for controlling problems of this nature.

1.1 Residential Home Construction

Homes having basements are generally constructed on concrete footings upon which concrete or cinder block basement walls are constructed. This involves digging a large hole in the ground in which the basement of the house is to be built. See figure 1.1.

In the bottom of the hole, trenches are dug into which concrete is poured for the footings. The basement wall is then constructed on these footings. Basement walls are generally constructed of concrete block or cinder block. However, basement walls of poured concrete, brick or other materials are sometimes used. Depending upon the local building codes, the builder may be required to parge the exterior face of the wall. Parging usually consists of applying a portland cement-sand mixture to the outside surface of the basement wall. Application of additional materials such as asphalt coatings covered with polyethylene sheeting, over the parging generally completes the waterproofing process.

At some point after the construction of the basement walls, a foundation is provided for the basement floor slab. This generally consists of a gravel bed. The floor slab is poured over this gravel, with the slab's edges resting on the previously placed footings. The area represented by the intersection of the floor slab, basement wall and the footings is referred to as the "cove area".

Frequently, perforated pipe underdrains are used to carry water away from the exterior basement walls. They are normally placed around the perimeter of the house, ideally below the intersection of the footing and wall. In areas where soils with poor drainage characteristics predominate, these underdrains are considered essential.

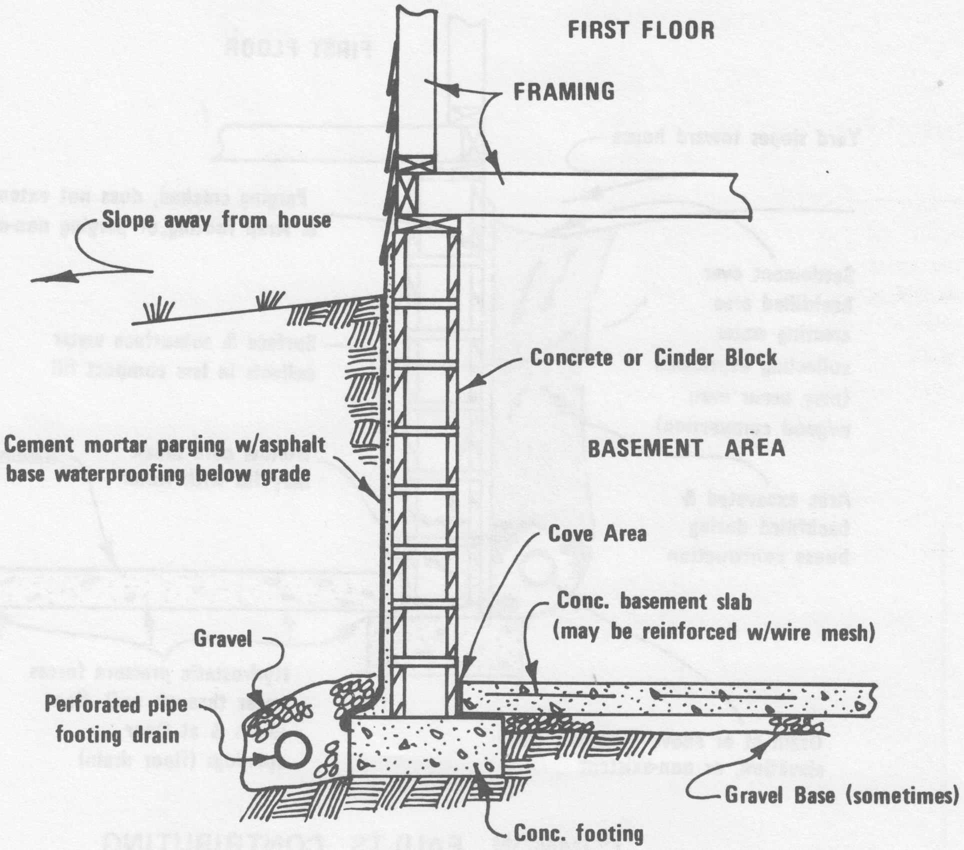
At some point after or during the construction of the house, the space between the outside basement wall and the edge of the foundation pit is filled-in with earth. In practice, this fill materials is not and often cannot be compacted to a density equal to that of the undisturbed soils around the house. Because of the density difference, the fill material is capable of conducting and holding more water than the soil around it and frequently provides a storage area for the soil water.

1.2 Causes of Basement Flooding

The choice of the solution (or solutions) needed to control basement flooding is considerably easier if the homeowner is able to identify the source of the flooding water. Generally, water entering basements comes from one or more of the following four sources: direct surface water inflow, surface water infiltration, groundwater infiltration or floor/areaway drain surcharge. General information on and identifiers for these sources of flooding are given in the following sections 1.2.1-4.

1.2.1 Direct Surface Water Inflow - What To Look For

This type of flooding is generally the result of overland surface drainage entering the basement via window wells, doorways, and/or cracks in the above-grade basement walls. This is often the easiest type of flooding to detect and remedy, since it usually occurs during or immediately following rainfall and the points where water enters can be seen.


FIRST FLOOR
FRAMING
Slope away from house
Concrete or Cinder Block
Cement mortar parging w/asphalt base waterproofing below grade
BASEMENT AREA
Cove Area
Conc. basement slab (may be reinforced w/wire mesh)
Gravel
Perforated pipe footing drain
Gravel Base (sometimes)
Conc. footing

TYPICAL RESIDENTIAL MASONRY BLOCK WALL CONSTRUCTION

FIGURE 1.1

1.2.2 Surface Water Infiltration - What to Look For

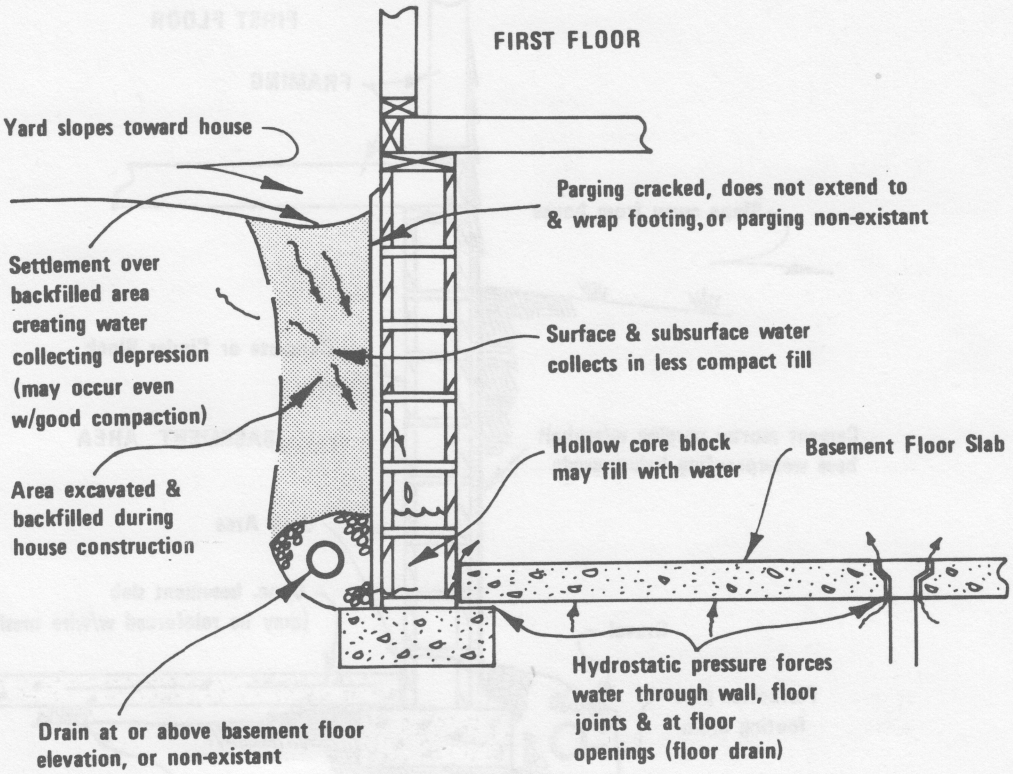
Flooding from this source is usually dependent upon three inter-related factors, as follows:

1) The ground surface slope and resultant drainage of rainwater around the house perimeter;

2) The rate at which water infiltrates the soil around the house;

3) The condition of the exterior basement waterproofing and underdrain system, if one was installed.

Typically, flooding occurs as a result of surface water infiltration in the following manner: The rainfall collects (ponds) on the ground surface adjacent to the home. Water, by taking the path of least resistance, flows into the loose backfill adjacent to the basement walls. See figure 1.2. If the undisturbed soils surrounding the house are relatively impermeable and a properly functioning underdrain system is not present, this water will collect in the backfill soil. Water pressure then builds up against the exterior of the basement walls. The condition of the exterior waterproofing now becomes critical. If it is in good condition, the water may build up sufficient pressure to crack the basement walls and allow the water in. If the exterior basement waterproofing has deteriorated at any point, the water will enter there. In either case, the water will be making a continuous effort to relieve the pressure it has built up on the outside of the basement walls by leaking into the basement. Since block walls are


FIRST FLOOR
Yard slopes toward house
Parging cracked, does not extend to & wrap footing, or parging non-existant
Settlement over backfilled area creating water collecting depression (may occur even w/good compaction)
Surface & subsurface water collects in less compact fill
Hollow core block may fill with water
Basement Floor Slab
Area excavated & backfilled during house construction
Hydrostatic pressure forces water through wall, floor joints & at floor openings (floor drain)
Drain at or above basement floor elevation, or non-existant

COMMON FAULTS CONTRIBUTING
TO SEEPAGE INTO BASEMENT

FIGURE 1.2

hollow, a defect on the exterior surface of the wall may result in the lower courses of block becoming filled with water. If the interior side of the block is sound, this condition may go unnoticed for a considerable period of time until the interior surface begins to leak.

Signs which suggest this source of flooding include leaking cracks in the interior basement walls and depressions or cracks, which appear to be well-drained, in the ground surface adjacent to the house.

1.2.3 Ground Water Infiltration

Some homes have been constructed with the basement floor elevations below the elevation of the ground water table. When this condition was recognized at the time of construction, an underdrain system with a gravity outlet or a sump pump system may have been included as an integral part of the basement waterproofing. In some cases, however, seasonal or drought-induced lowering in the ground water elevation may have hidden the fact that the situation existed. When the ground water table is above the basement floor slab elevation, water pressure will be exerted against the exterior basement walls. If there is no functioning system to drain this water and relieve the pressure, the water will inevitably penetrate into the basement.

Indications that this is the source of flooding include seepage of water into the basement along the connection between the floor slab and the walls and infiltration upward through cracks in the basement floor slab and around the outside of the basement floor drains during wet periods when the water table is high.

1.2.4 Surcharge

In some cases basement flooding is the result of surcharge (water being forced out of a drain under pressure). This situation can occur if the floor drains, foundation drains, etc. are connected to a sanitary sewer or public storm drain system which is at or near the basement floor elevation. If flooding from this source is suspected, (1) the water should be tested to make sure the condition is not related to a sanitary sewerage system source and (2) the elevation of nearby storm drain systems should be checked, in that order. If surcharge is determined to be the cause of flooding, an alternative means of discharge may have to be found for the floor drains or, in some cases, installation of a one-way discharge ("backwater") valve may be used to correct the problem.

1.2.5 Determining the Best Course of Action

Most of the flooding problems outlined in the preceding sections can be controlled by various waterproofing measures, or combinations of such measures. There are some instances where it may not be possible to completely eliminate the flooding problem due to specific site conditions or the homeowner may not be able to undertake the necessary corrective measures. In such a case, it may be desirable to consider alternative uses for the basement area, such as storage of items not affected by water or dampness. If flood depths do not exceed several inches, appliances and heating equipment may be elevated on platforms or blocks and electrical connections may be relocated as necessary.*

The homeowner should make every effort to evaluate the severity of the flooding problem and determine the source of the flood water. This evaluation will provide a sound background for use in determining which remedial measures would be best suited to control the problem.

1.3 Remedial Measures by the Homeowner

This section outlines measures which should be utilized to divert rainfall surface drainage away from the house. Regardless of the source of flooding being experienced, drainage around the house should be checked and the necessary corrections should be made, even if flooding from this source is not now a problem.

1.3.1 Roof Drainage Systems

Water from downspouts should be discharged far enough from the side of the house to prevent discharge from flowing back toward the home. A distance of three to four feet is usually sufficient for this purpose. The intent here is to prevent the water from infiltrating into the fill material adjacent to the basement. Concrete splash blocks and rigid or flexible downspout extensions are commercially available for this purpose.

1.3.2 Grading

Regrading as necessary to insure positive drainage away from all sides of the house will aid in preventing the entrance of surface water into the fill material adjacent to the basement walls. **See figure 1.3.** Where fill material is being used to raise the ground surface elevations, be sure to use a non-organic and root-free soil that is relatively impervious to water (such as clay). These soils, in turn, can be covered with top soil and seeded or sodded after they are placed and compacted. **See figure 1.3.** Avoid planting exterior flower beds next to the house. Such beds consist of loose, easily infiltrated soils which provide easy access for water into the soil beside the basement walls.

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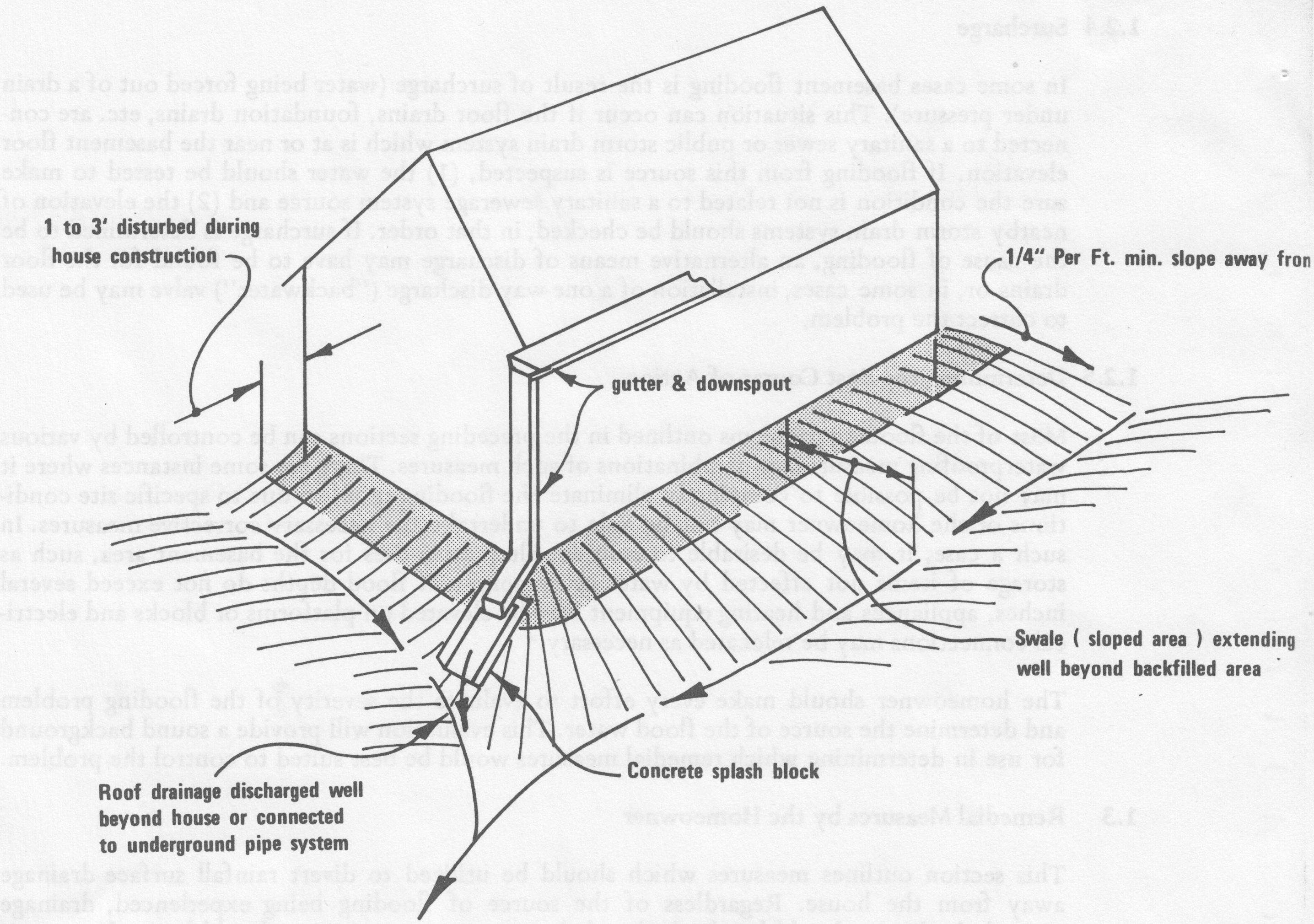
* *Information on insurance coverage to help protect against financial loss as a result of flooding is provided in Appendix B.*


1 to 3' disturbed during
house construction
1/4" Per Ft. min. slope away fron
gutter & downspout
Swale (sloped area) extending
well beyond backfilled area
Concrete splash block
Roof drainage discharged well
beyond house or connected
to underground pipe system

GRADING AROUND HOUSE

FIGURE 1.3

1.3.3 French Drains

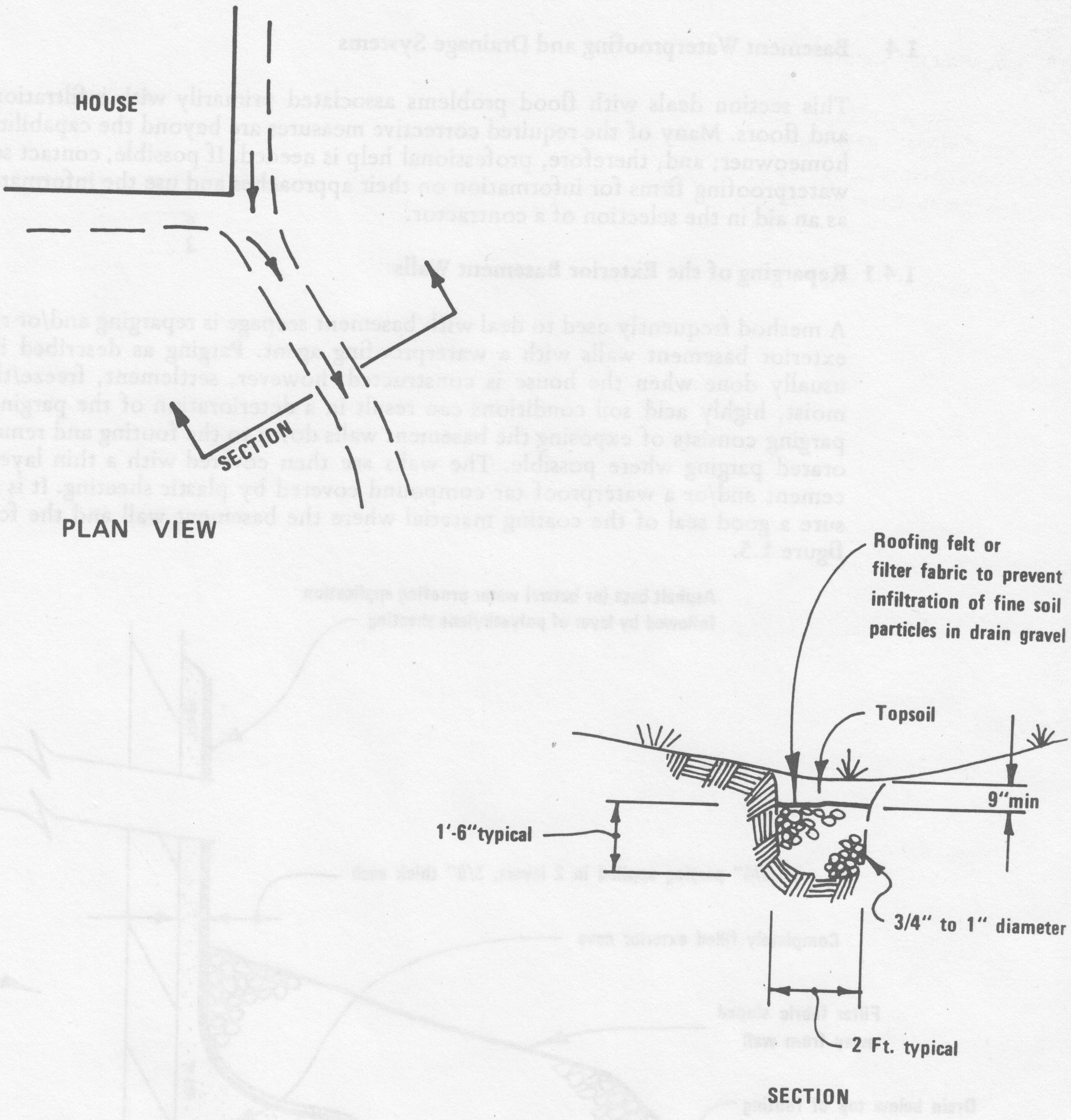
French Drains are used to help de-water saturated soil. They can be useful in helping to alleviate wet basements by removing water from the soil before it enters the fill material adjacent to the basement wall. French Drains are also used when it is desirable to keep the yard space dry in areas with active ground water.

Simple French Drains consist of trenches filled with gravel. Dependent upon the conditions, French Drains may be augmented by the use of filter fabric, and/or plastic pipe. See figure 1.4.

The effectiveness of this type of treatment is closely tied to three factors: (1) the existence of a suitable discharge point, (2) the depth of the trench and (3) the slope of the trench.

A suitable discharge for the drain usually means an open stream, swale, ditch or slope to which the drain can be run. If such a discharge point is not available a French Drain is generally not feasible.

The trench should be dug to a sufficient depth to insure the capture of soil water having the potential to infiltrate the fill material in the footing area of the basement. The slope of the trench should be such that good flow can be maintained between the gravel stones. This generally means a minimum slope of 1.0% or a drop ("fall") of 1/8 inch per foot of length.


HOUSE
SECTION
PLAN VIEW
Roofing felt or filter fabric to prevent infiltration of fine soil particles in drain gravel
Topsoil
9"min
1'-6"typical
3/4" to 1" diameter
2 Ft. typical
SECTION

Typical French Drain
(in this case , used in lieu of pipe)

FIGURE 1.4

1.3.4 Preventing Surface Water Inflows

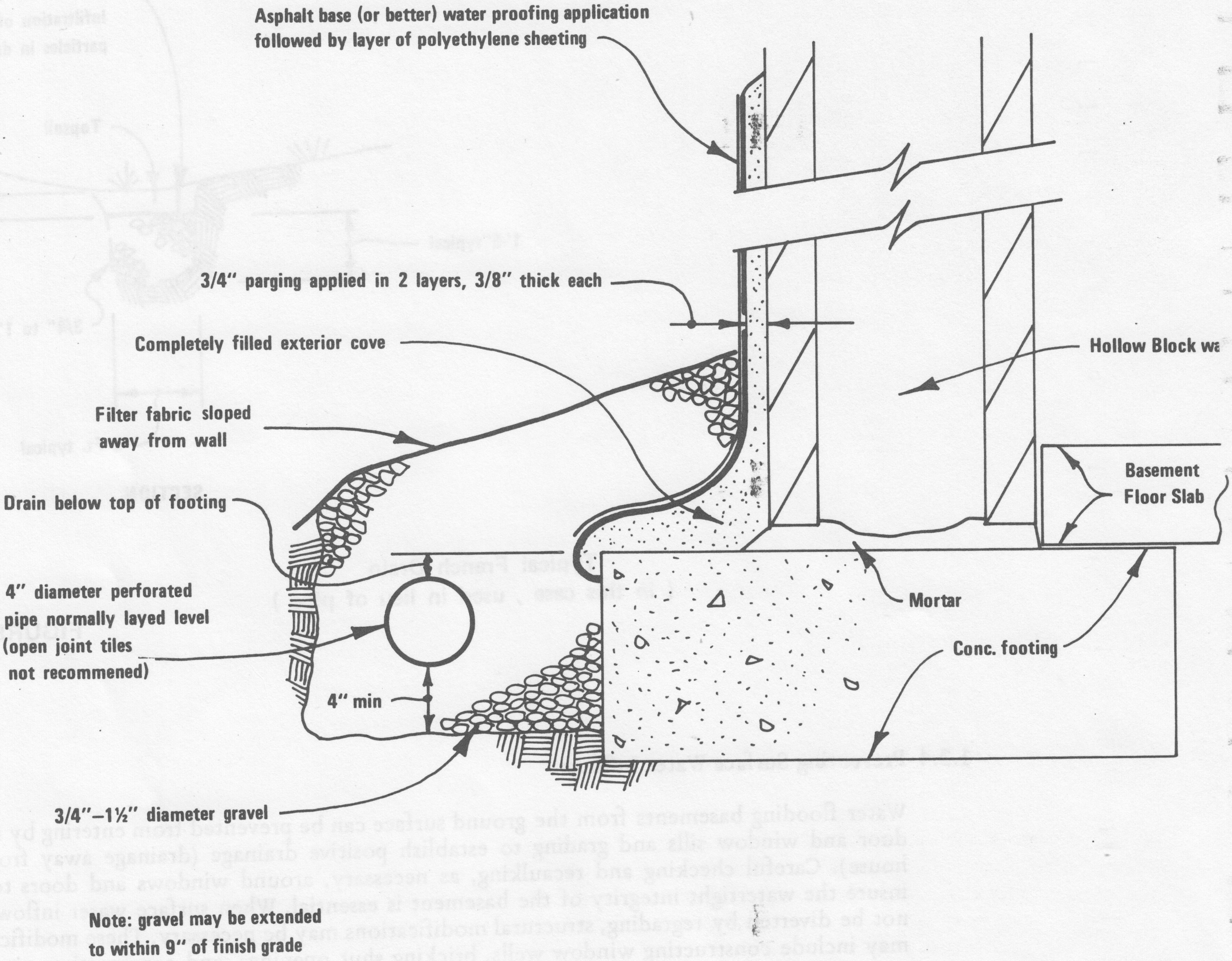
Water flooding basements from the ground surface can be prevented from entering by raising door and window sills and grading to establish positive drainage (drainage away from the house). Careful checking and recaulking, as necessary, around windows and doors to help insure the watertight integrity of the basement is essential. When surface water inflows cannot be diverted by regrading, structural modifications may be necessary. These modifications may include constructing window wells, bricking shut openings, and constructing raised sills around doorways and stairwell entrances. All masonry work should be relatively watertight, and special care should be taken to seal joints and connections to exterior walls.

1.4 Basement Waterproofing and Drainage Systems

This section deals with flood problems associated primarily with infiltration through walls and floors. Many of the required corrective measures are beyond the capability of the typical homeowner; and, therefore, professional help is needed. If possible, contact several basement waterproofing firms for information on their approaches and use the information given below as an aid in the selection of a contractor.

1.4.1 Reparging of the Exterior Basement Walls

A method frequently used to deal with basement seepage is reparging and/or repainting of the exterior basement walls with a waterproofing agent. Parging as described in section 1.1 is usually done when the house is constructed; however, settlement, freeze/thaw action and moist, highly acid soil conditions can result in a deterioration of the parging materials. Reparging consists of exposing the basement walls down to the footing and removing the deteriorated parging where possible. The walls are then covered with a thin layer of waterproof cement and/or a waterproof tar compound covered by plastic sheeting. It is important to insure a good seal of the coating material where the basement wall and the footing meet. See figure 1.5.


Asphalt base (or better) water proofing application followed by layer of polyethylene sheeting
3/4" parging applied in 2 layers, 3/8" thick each
Completely filled exterior cove
Hollow Block wa
Filter fabric sloped away from wall
Basement Floor Slab
Drain below top of footing
Mortar
4" diameter perforated pipe normally layed level (open joint tiles not recommened)
Conc. footing
4" min
3/4"–1½" diameter gravel
Note: gravel may be extended to within 9" of finish grade

DETAILS OF UNDERDRAIN AND FOUNDATION WATERPROOFING

FIGURE 1.5

Information on the acidity and permeability of soils in your area can be obtained, at no cost, from the U.S. Department of Agricultural Soil Conservation Service and the County Horticultural Agent, Agricultural Extension Service (see Appendix A). This information can be used in selecting an appropriate waterproofing system for your soil conditions.

It is important to remember that this type of reparging, by itself, does not insure the avoidance of build up of water pressure against the exterior basement walls, with the resultant possibility of cracking and subsequent leakage. This possibility can be reduced if surface and ground water are prevented from entering the backfill walls, be sure the fill material is well compacted in shallow layers and is of low permeability. Grade the surface soils so that there is positive drainage away from the house on all sides. If your flooding problem stems from a ground water source, it may be necessary to include an exterior underdrain system, described in the following section. Since the major cost is in the excavation to expose the wall, such a system is recommended as inexpensive additional insurance against seepage.

1.4.2 Exterior Underdrain System

This measure combined with reparging is generally the most reliable waterproofing system. The advantage of an underdrain system is that it will remove water which would otherwise exert pressure against the basement walls and floors. In the past, underdrains usually consisted of clay tiles or clay pipe segments were laid on a gravel bed with a gap of approximately one-half inch between pipe segments, the gap would allow water to enter the pipe segments and be carried to a discharge point. This type of system is prone to failure due to settlement of the clay pipe and the difficulty of cleanout operations. Modern underdrains, see figure 1.6, are generally constructed of continuous perforated plastic pipe. This pipe is laid on a gravel filter bed with drain holes facing down and, in some cases, covered with an additional filter material before backfilling. The underdrains are placed along the building foundation just below the footing and carry water they collect to a gravity discharge or sump pump for disposal in a public drainage system, a free flowing natural drainage or onto the ground surface (as permitted by local regulatory agencies).

1.4.3 Interior Drain Systems

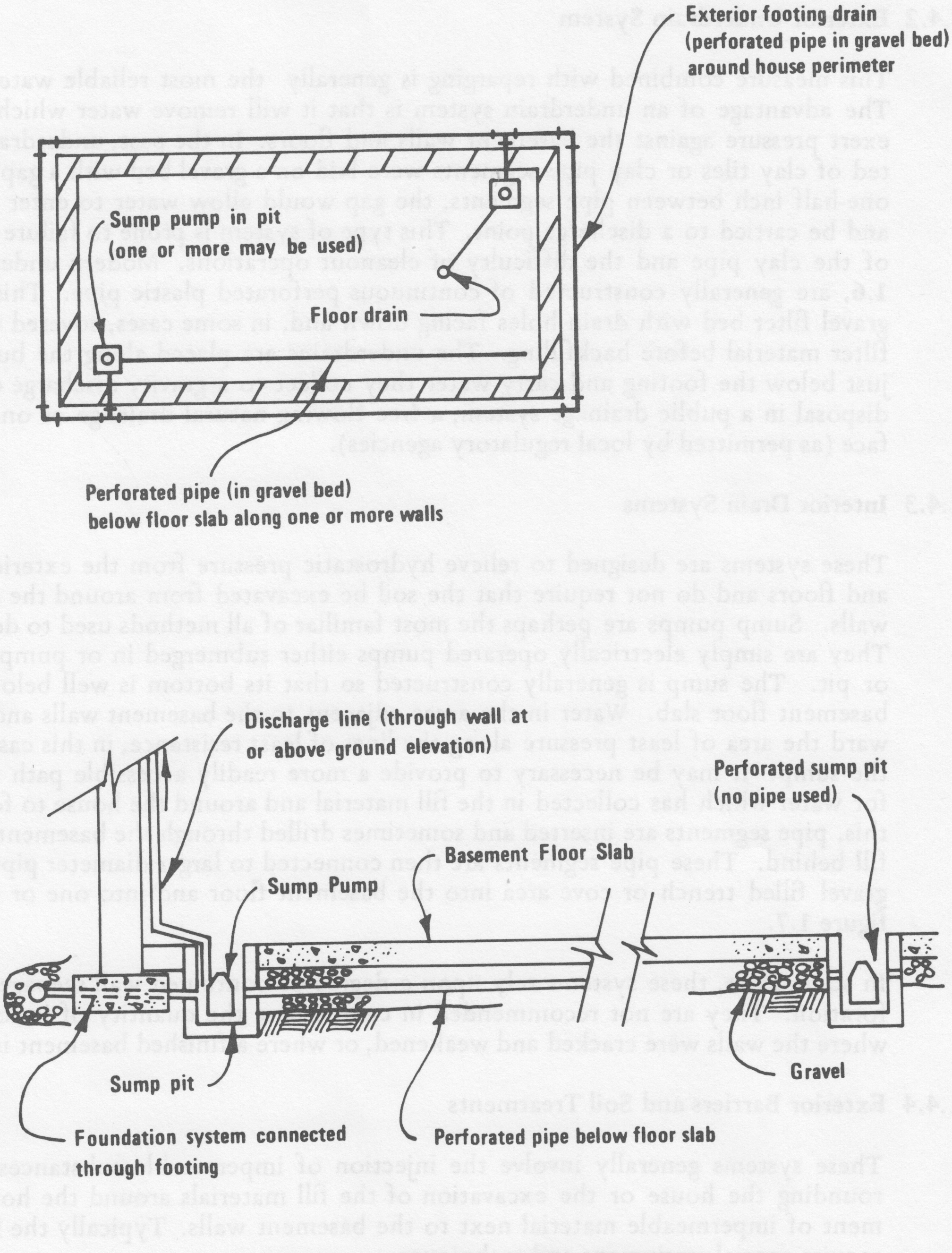
These systems are designed to relieve hydrostatic pressure from the exterior basement walls and floors and do not require that the soil be excavated from around the exterior basement walls. Sump pumps are perhaps the most familiar of all methods used to dewater basements. They are simply electrically operated pumps either submerged in or pumping out of a sump or pit. The sump is generally constructed so that its bottom is well below the base of the basement floor slab. Water in the areas adjacent to the basement walls and floor migrate toward the area of least pressure along the lines of least resistance, in this case toward and into the sump. It may be necessary to provide a more readily accessible path of least resistance for water which has collected in the fill material and around the house to follow. To achieve this, pipe segments are inserted and sometimes drilled through the basement wall and into the fill behind. These pipe segments are then connected to larger diameter pipes running along a gravel filled trench or cove area into the basement floor and into one or more sumps. See figure 1.7.

In some cases, these systems rely upon a degree of continued wall seepage or deliberate perforation. They are not recommended in cases where the quantity of inflow would be large, where the walls were cracked and weakened, or where a finished basement is desired.

1.4.4 Exterior Barriers and Soil Treatments

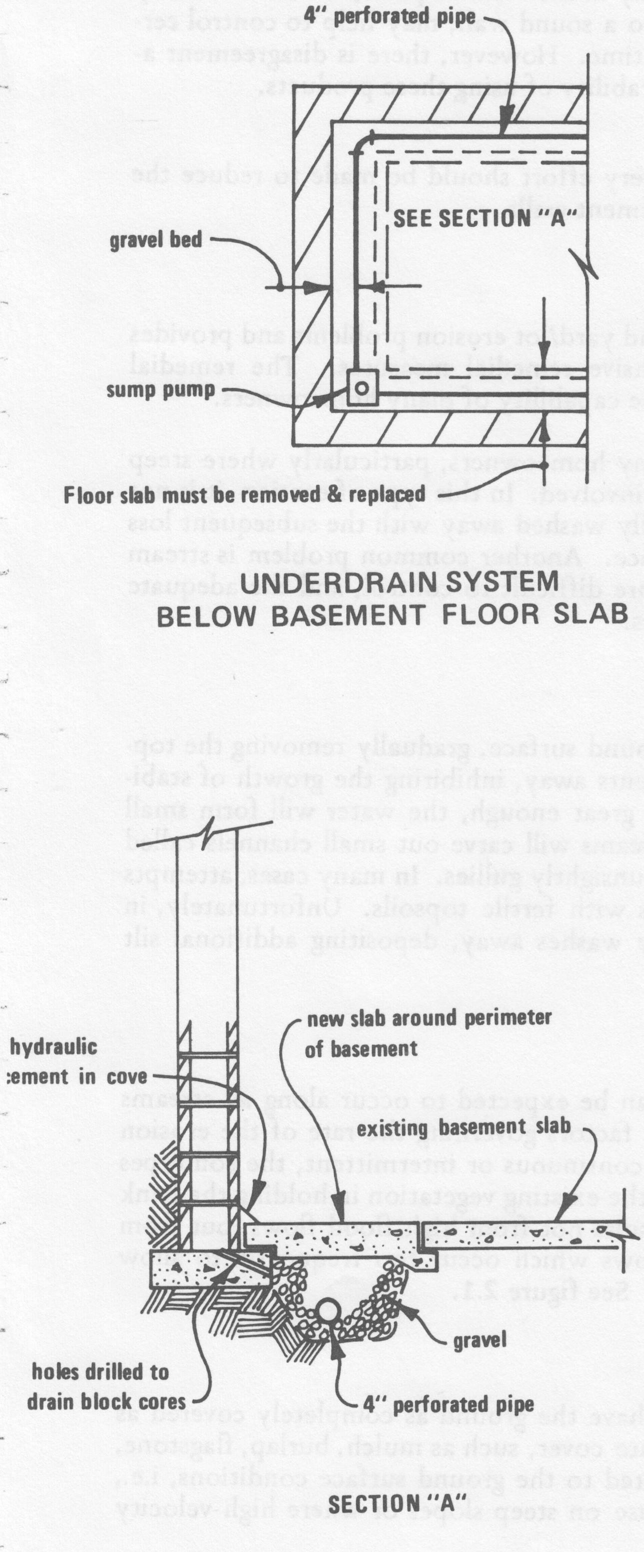
These systems generally involve the injection of impermeable substances into the soil surrounding the house or the excavation of the fill materials around the house and the placement of impermeable material next to the basement walls. Typically the injection processes require special equipment and techniques.

Materials used in the injection system are silicone compounds and bentonite clays. The intent of these systems is to create a wall of impermeable material designed to prevent the horizontal movement of soil water into the fill material outside the basement wall. One drawback of the injection method is that it does not lend itself to inspection during installation and, therefore, it is difficult to guarantee an unbroken wall of impermeable material. Success also depends on the experience and knowledge of the contractor and the type of soils being treated.

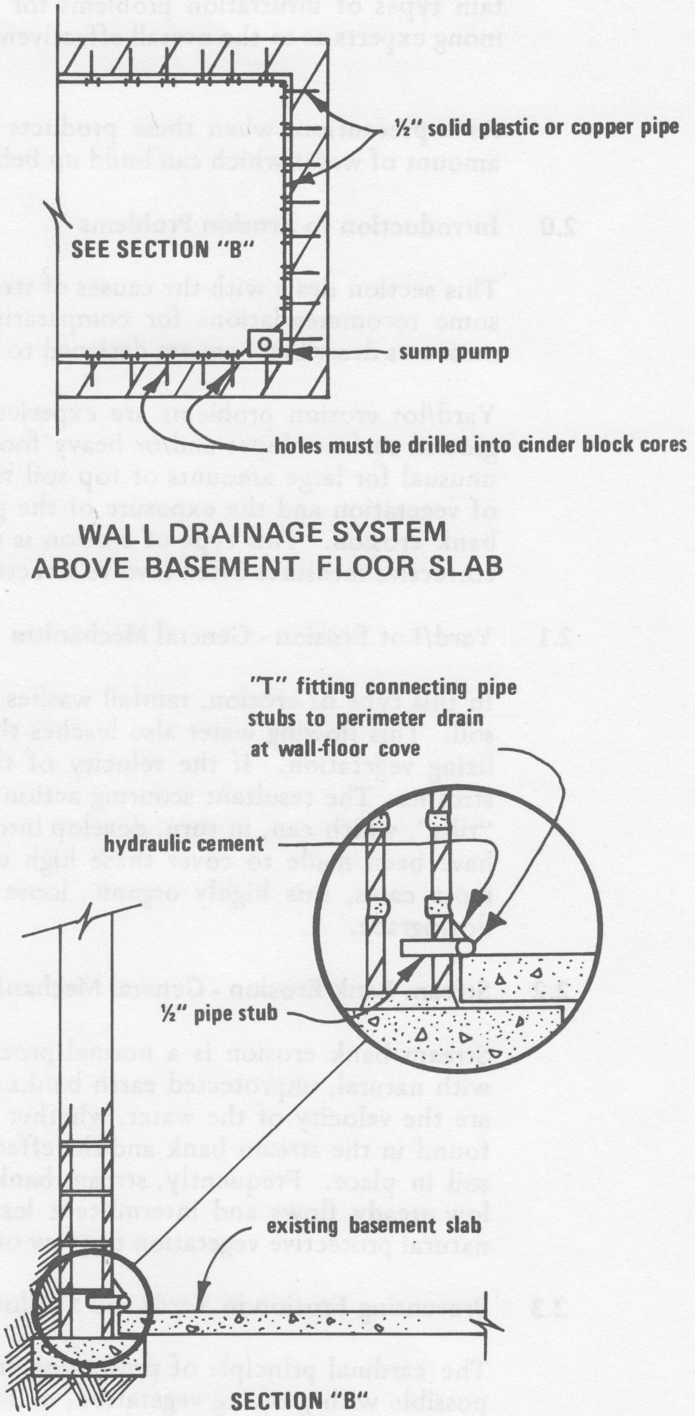

Exterior footing drain
(perforated pipe in gravel bed)
around house perimeter
Sump pump in pit
(one or more may be used)
Floor drain
Perforated pipe (in gravel bed)
below floor slab along one or more walls
Discharge line (through wall at
or above ground elevation)
Perforated sump pit
(no pipe used)
Basement Floor Slab
Sump Pump
Gravel
Sump pit
Foundation system connected
through footing
Perforated pipe below floor slab

TYPICAL SUMP PUMP SYSTEM

FIGURE 1.6



Note: water is collected in sump & must be pumped to a suitable point of discharge.



Note: Holes must be drilled into block cores at 8" intervals as close to floor as possible. This method must be considered an inexpensive alternative to a below slab system and accordingly has certain shortcomings: pipe is visable; will not drain well below floor elevation; problems associated with dampness may remain; hydrostatic pressure below floor slab may not be sufficiently relieved.

INTERIOR DRAINAGE SYSTEMS

FIGURE 1.7 A

FIGURE 1.7 B

1.4.5 Interior Wall Treatments.

Various types of waterproofing applications, typically in the form of paint, are commercially available. These materials, when properly applied to a sound wall, may help to control certain types of infiltration problems for a period of time. However, there is disagreement among experts as to the overall effectiveness and desirability of using these products.

As a precaution, when these products are used, every effort should be made to reduce the amount of water which can build up behind the basement walls.

2.0 Introduction to Erosion Problems

This section deals with the causes of stream bank and yard/lot erosion problems and provides some recommendations for comparatively inexpensive remedial measures. The remedial measures described here are designed to be within the capability of many homeowners.

Yard/lot erosion problems are experienced by many homeowners, particularly where steep ground surface slopes and/or heavy foot traffic are involved. In this type of erosion, it is not unusual for large amounts of top soil to be gradually washed away with the subsequent loss of vegetation and the exposure of the ground surface. Another common problem is stream bank erosion. This type of erosion is typically more difficult to control, and the adequate corrective measures often involve structural solutions.

2.1 Yard/Lot Erosion - General Mechanism

In this type of erosion, rainfall washes over the ground surface, gradually removing the topsoil. This flowing water also leaches the soil nutrients away, inhibiting the growth of stabilizing vegetation. If the velocity of this water is great enough, the water will form small streams. The resultant scouring action of these streams will carve out small channels called "rills", which can, in turn, develop into dangerous unsightly gullies. In many cases, attempts have been made to cover these high erosion areas with fertile topsoils. Unfortunately, in most cases, this highly organic, loose soil quickly washes away, depositing additional silt downgrade.

2.2 Stream Bank Erosion - General Mechanism

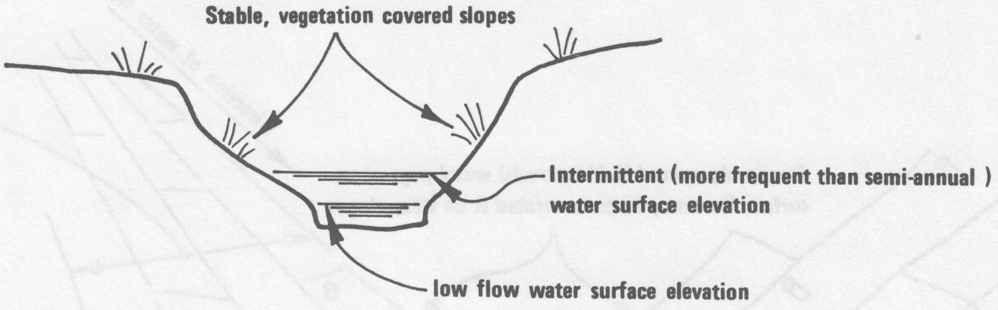
Stream bank erosion is a normal process which can be expected to occur along all streams with natural, unprotected earth banks. The major factors governing the rate of the erosion are the velocity of the water, whether the flow is continuous or intermittent, the soil types found in the stream bank and the effectiveness of the existing vegetation in holding the bank soil in place. Frequently, stream bank erosion results not from high flood flows, but from low steady flows and intermittent lesser flood flows which occur too frequently to allow natural protective vegetation to grow on the banks. **See figure 2.1.**

2.3 Preventing Erosion in Yards and Shallow Drainages

The cardinal principle of preventing erosion is to have the ground as completely covered as possible with growing vegetation, or some substitute cover, such as mulch, burlap, flagstone, or gravel. The type of surface cover must be suited to the ground surface conditions, i.e., mulch and small gravel are not appropriate for use on steep slopes or where high velocity flows are normal.

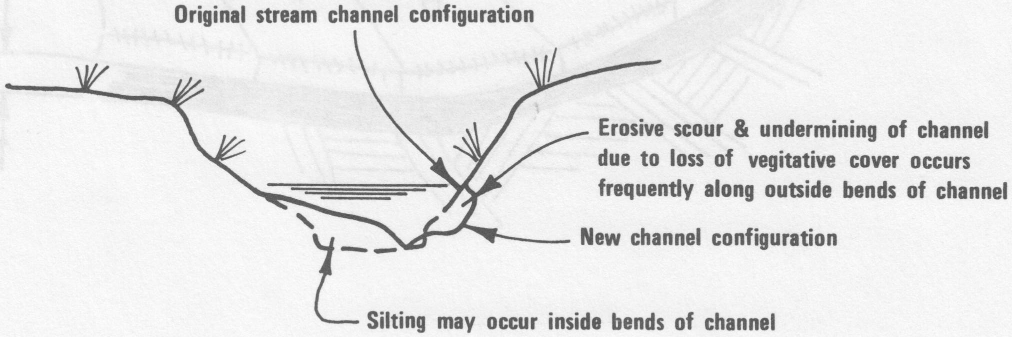
2.3.1 Sod

Sod provides an extremely effective and readily available source of protection for shallow intermittent drainages. When placed parallel to the direction of the water's flow, as shown in figure 2.2, and firmly secured to the ground surface with wooden stakes or sod staples, the sod channel can "take hold" and provide an attractive, easy to maintain drainage.


Stable, vegetation covered slopes
Intermittent (more frequent than semi-annual)
water surface elevation
low flow water surface elevation

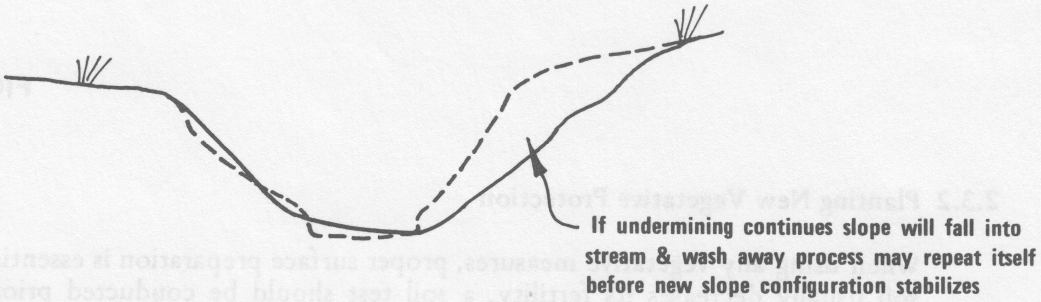
I

PRE-EROSION STREAM CHANNEL CONFIGURATION


Original stream channel configuration
Erosive scour & undermining of channel
due to loss of vegitative cover occurs
frequently along outside bends of channel
New channel configuration
Silting may occur inside bends of channel

II

STREAM CHANNEL BEGINS TO ERODE

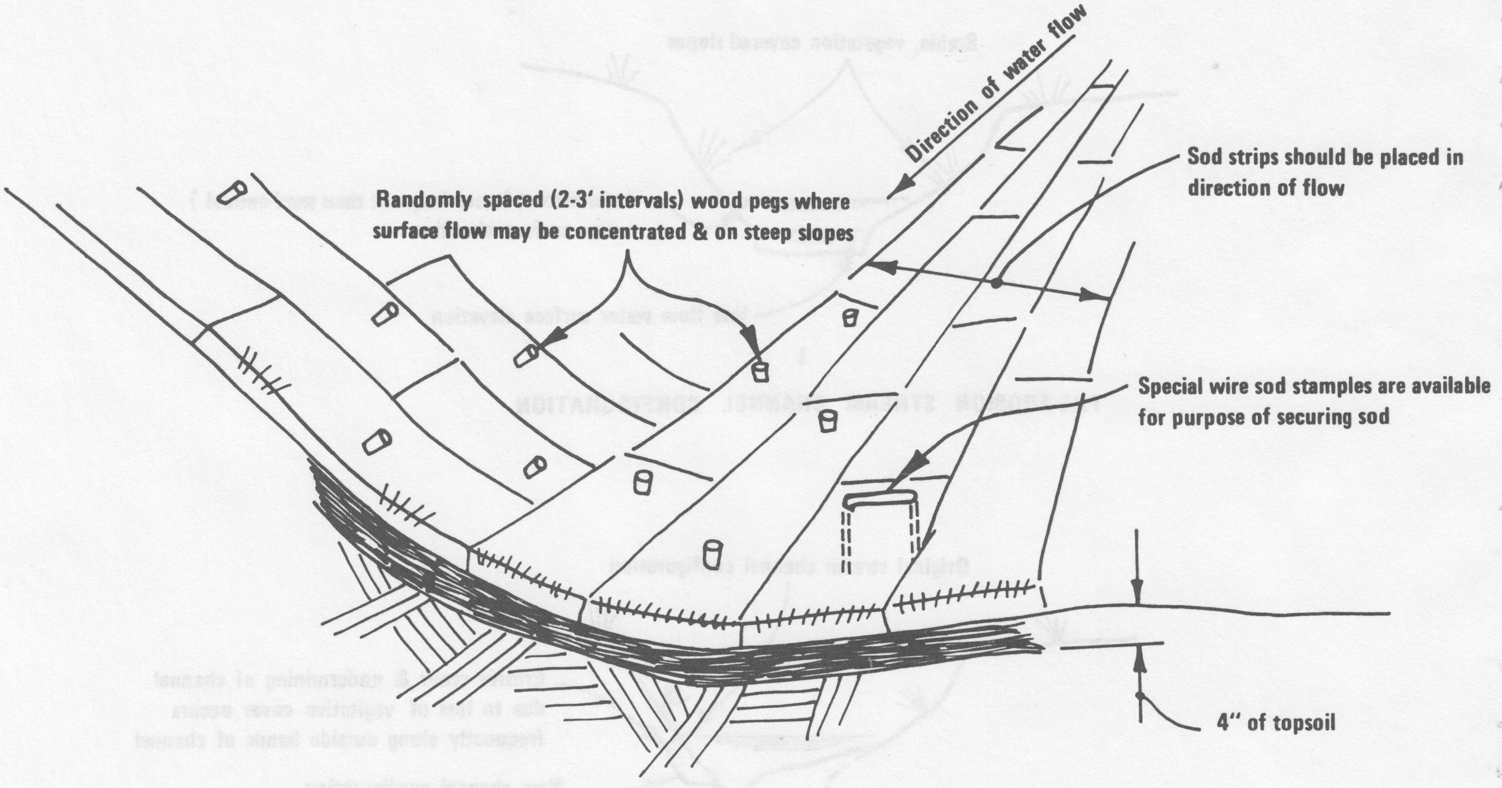

If undermining continues slope will fall into
stream & wash away process may repeat itself
before new slope configuration stabilizes

III

EROSION CONTINUES FLATTING STREAM BANKS

TYPICAL STREAM BANK EROSION SEQUENCE

FIGURE 2.1


Direction of water flow
Sod strips should be placed in direction of flow
Randomly spaced (2-3' intervals) wood pegs where surface flow may be concentrated & on steep slopes
Special wire sod stamples are available for purpose of securing sod
4" of topsoil

Note: Care should be taken to insure that no gaps exist between sod stripes.

PLACEMENT OF SOD ON WATERWAY AREAS

FIGURE 2.2

2.3.2 Planting New Vegetative Protection

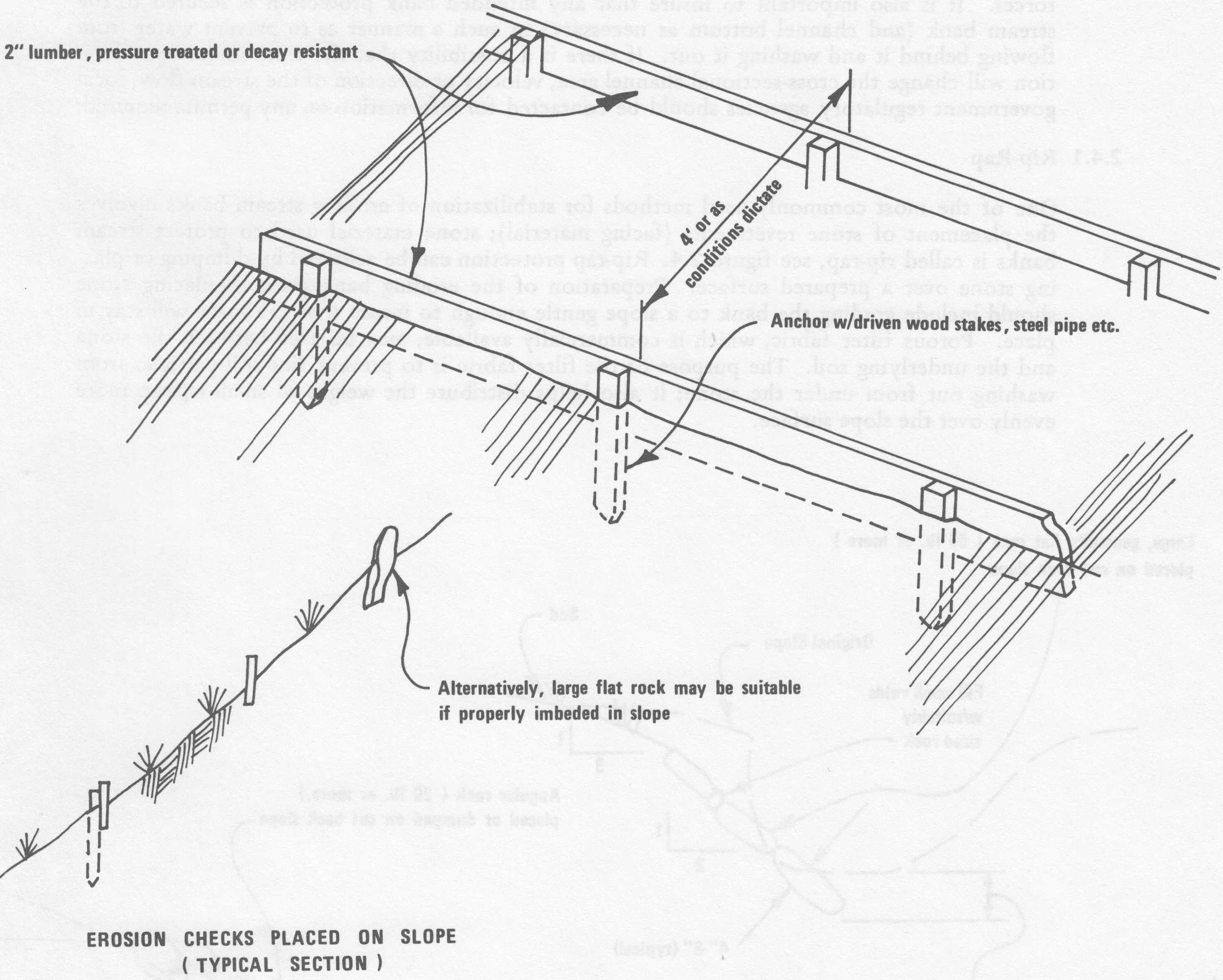
When using any vegetative measures, proper surface preparation is essential. Since the loss of soil usually decreases its fertility, a soil test should be conducted prior to the planting of ground cover. This can be done by the State Agricultural Extension Service at no cost. Accompanying the results of the soil test will be planting recommendations, which can be used as a guide. Recommended grasses and other vegetative covers for the Washington Metropolitan Area are listed in Appendix C.

Prior to the seeding of the new turf, the surface of the soil should be raked or roughed to prepare a suitable seed bed. If the area will be subjected to runoff before the plant cover is established, soil protection should be provided in the form of straw, burlap mats or commercially available soil mats. Mats of heavily woven jute or paper will hold soil in place on slopes, drainage ways and other areas of intermittent concentrated flow. Some mats are designed to be laid over seeded surfaces; the grass will grow through the mat, which will eventually decompose as the turf becomes established.

The following sections outline some of the methods which may be considered for controlling stream bank erosion.

2.3.3 Erosion Checks

In areas where extensive erosion or gullying has occurred, it may be necessary to install simple timber or rock erosion checks. These measures, see figure 2.3, will serve to trap eroding soils before they can wash downgrade and will help establish a stable base for further landscaping efforts.


2" lumber, pressure treated or decay resistant
4' or as conditions dictate
Anchor w/driven wood stakes, steel pipe etc.
Alternatively, large flat rock may be suitable if properly imbeded in slope
EROSION CHECKS PLACED ON SLOPE
(TYPICAL SECTION)

SLOPE EROSION CHECKS

FIGURE 2.3

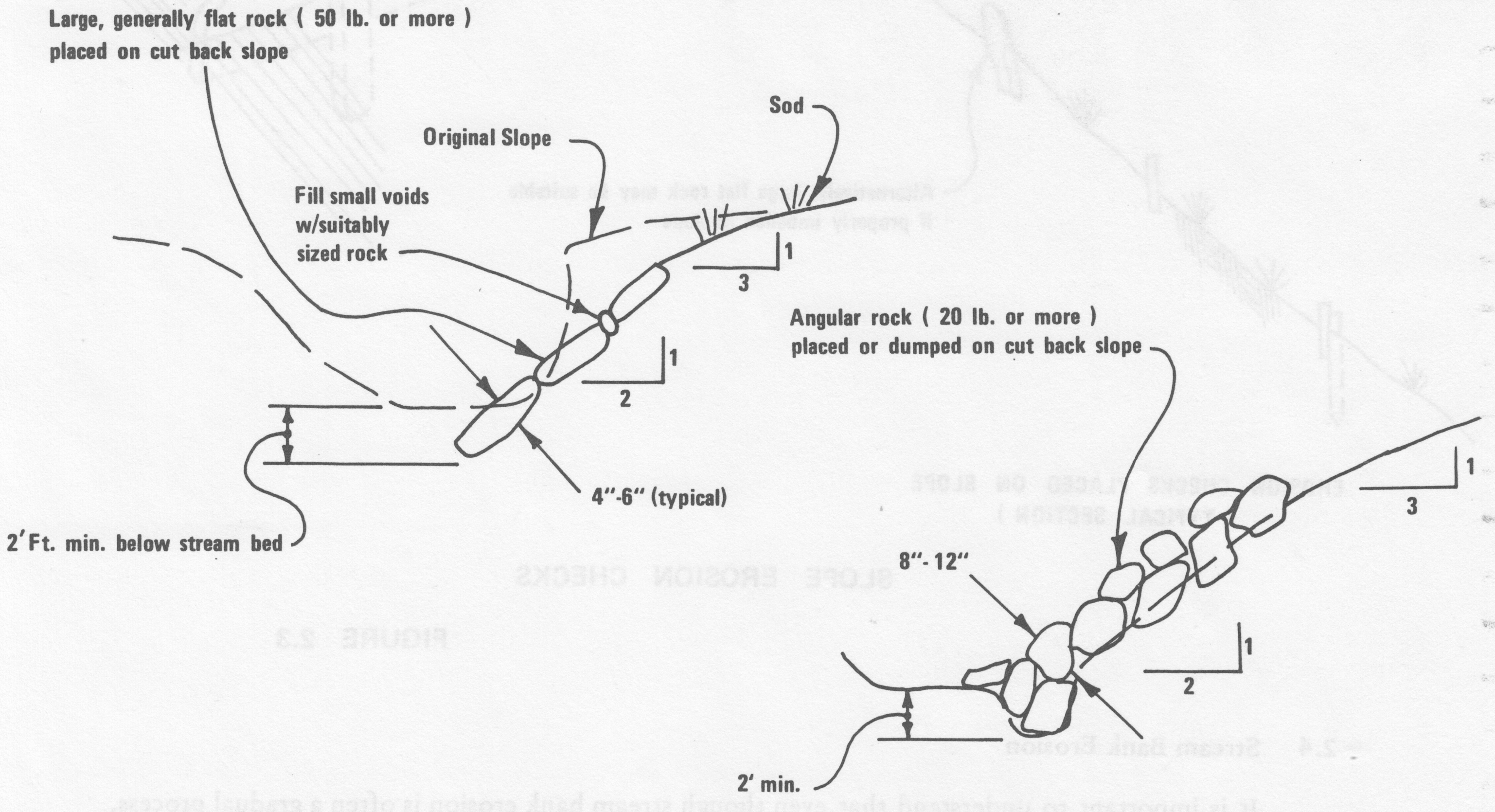
2.4 Stream Bank Erosion

It is important to understand that even though stream bank erosion is often a gradual process, major storms can result in rapid loss of large ground areas. In some cases, efforts to interfere with or control this erosion may appear to be futile as the power of the stream under severe conditions can undermine and remove even very massive structures. With this in mind, valuable improvements should be placed at least twice as far from a stream bank as the width between the banks whenever possible. These measures are especially important along the outside of a bend or just downstream from a bend in the stream. Measures to control stream bank erosion should only be considered when the erosion is creating a hazardous situation or severely limiting the use of property.

The basic principle of any structural erosion control measure should be to provide a flexible or semi-flexible structure capable of withstanding minor damage. Rigid masonry structures are prone to unrepairable damage due to loss of earth support, freeze/thaw action, and hydraulic forces. It is also important to insure that any intended bank protection is secured to the stream bank (and channel bottom as necessary) in such a manner as to prevent water from flowing behind it and washing it out. If there is a possibility that the work under consideration will change the cross-sectional channel area, velocity or direction of the stream flow, local government regulatory agencies should be contacted for information on any permits required.

2.4.1 Rip-Rap

One of the most commonly used methods for stabilization of eroding stream banks involves the placement of stone revetments (facing material); stone material used to protect stream banks is called rip-rap, see figure 2.4. Rip-rap protection can be achieved by dumping or placing stone over a prepared surface. Preparation of the eroding bank prior to placing stone should include grading the bank to a slope gentle enough to insure that the stone will stay in place. Porous filter fabric, which is commercially available, may be used between the stone and the underlying soil. The purpose of the filter fabric is to prevent fine soil particles from washing out from under the stone; it also helps distribute the weight of small rip-rap more evenly over the slope surface.


Large, generally flat rock (50 lb. or more)
placed on cut back slope
Sod
Original Slope
Fill small voids
w/suitably
sized rock
1
3
1
2
4"-6" (typical)
2'Ft. min. below stream bed
Angular rock (20 lb. or more)
placed or dumped on cut back slope
1
3
8"-12"
1
2
2' min.

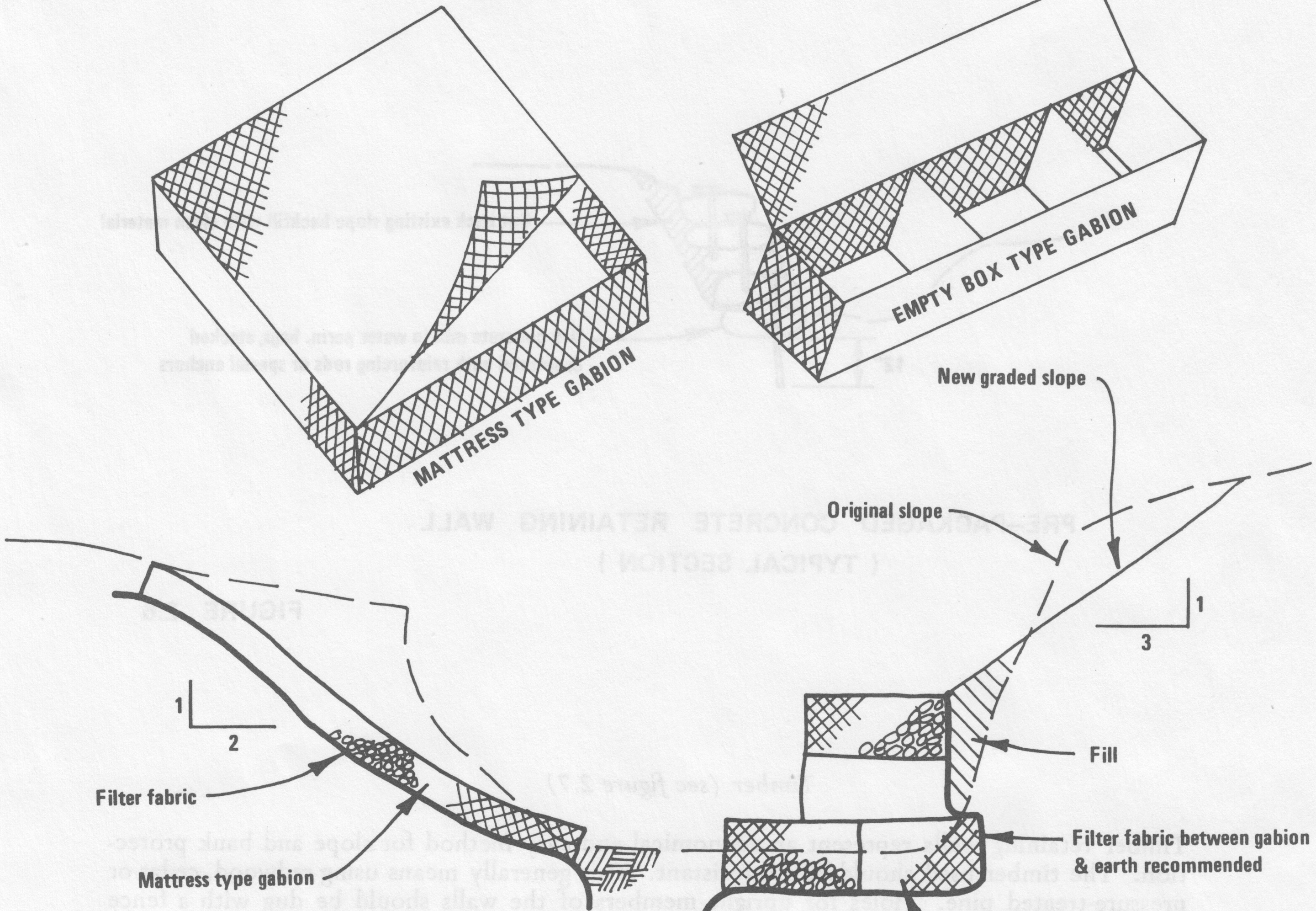
RIP—RAP SLOPE PROTECTION ON STREAM BANKS
(TYPICAL SECTIONS)

FIGURE 2.4

2.4.2 Gabions

Gabions are compartmentalized rectangular cages made of heavy galvanized steel wire mesh which, when they are filled with stone, become a flexible and permeable building block, see figure 2.5. They come in various sizes, ranging from one cubic yard in volume to almost two and one-half cubic yards covering from 18 to 78 square feet of ground. The amount of stone required to fill the gabions varies with their size. Individual gabions are wired together and filled with stone of an appropriate size to form a continuous stone-filled mat or retaining wall. The completed structure forms a continuous layer and acts as a unit to stresses imposed by soil movement and hydraulic action. Frost heaving or normal ground settlement will only minimally affect these pervious structures. Water will seep through from behind the wall preventing a build up of hydrostatic pressure.

As with the installation of rip-rap, it is essential that the ground on which the gabions are to be placed be prepared to insure a stable, permanent structure. When installed on the prepared surface, the gabions are held in place by anchors driven into the slope to prevent their migration downstream.



GABION MATTRESS SLOPE PROTECTION

GABION RETAINING WALL

GABION SLOPE PROTECTION

Note: In situations involving free flowing streams it is usually necessary to cut-back slope since reduction in stream cross section is not generally permissable

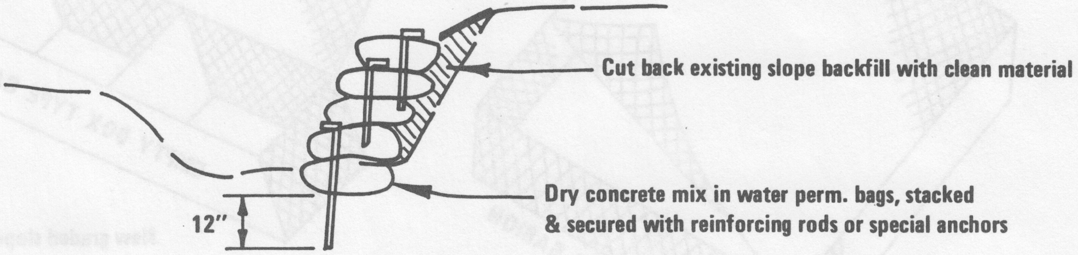
FIGURE 2.5

2.4.3 Small Retaining Walls

Small retaining structures placed at the base of eroding slopes will aid in stabilizing the slope material and help prevent the continuation of the erosion. The walls described in this section should be generally three feet or less in height. Higher walls and walls retaining a large amount of fill material involve special structural considerations, which are not covered in this publication. With all stream bank retaining walls, care should be taken to insure that the structure is not subject to undermining or washing out from the sides. In order to avoid these problems, the wall should be firmly anchored in the stream bottom and the upstream wall should extend into the stable stream bank.

Pre-Packaged Concrete (see figure 2.6)

Pre-packaged concrete represents one of the easiest methods of constructing retaining walls and stream bank revetments. 60-90 pound paper or polypropane bags of sand mix concrete can be stacked and wetted in place. By anchoring them to a prepared slope with reinforcing rods or staples, a permanent wall can be constructed.

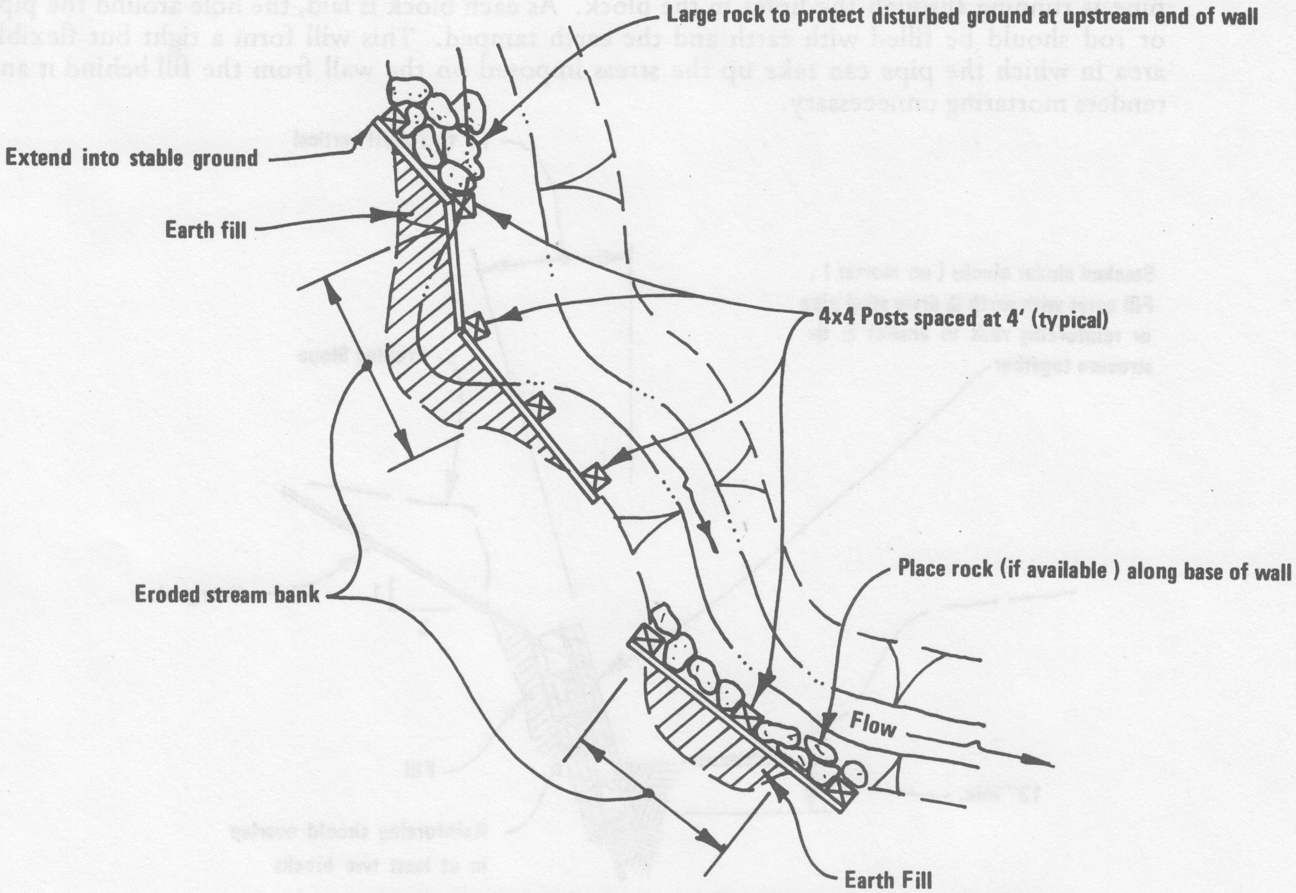

Cut back existing slope backfill with clean material
Dry concrete mix in water perm. bags, stacked & secured with reinforcing rods or special anchors
12"

PRE–PACKAGED CONCRETE RETAINING WALL
(TYPICAL SECTION)

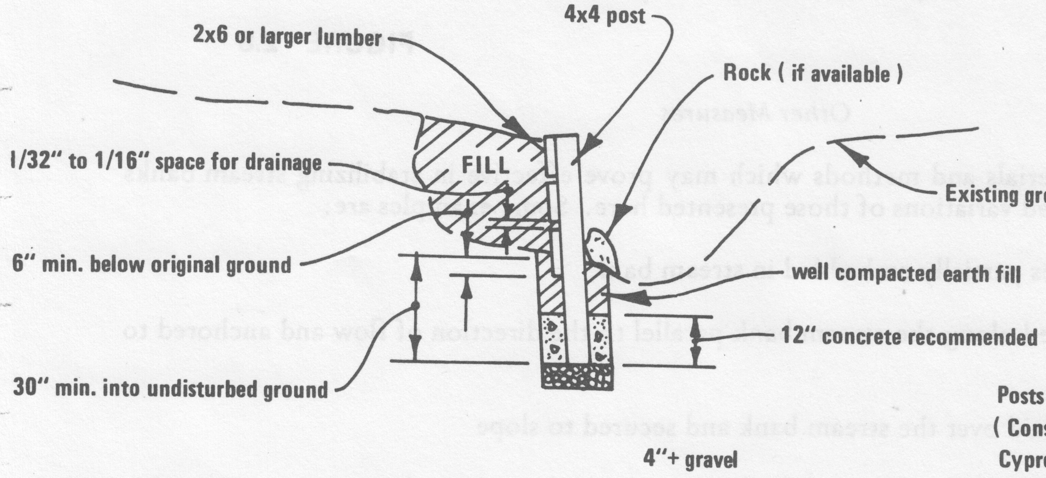
FIGURE 2.6

Timber (see figure 2.7)

Timber retaining walls represent an economical and easy method for slope and bank protection. The timber used should be rot-resistant. This generally means using redwood, cedar or pressure-treated pine. Holes for upright members of the walls should be dug with a fence posthole-digger to a depth of approximately three feet. Posts are then secured by tamping earth around them or by setting them in poured concrete. If concrete is used, the posts should be set on a four-inch minimum layer of gravel to insure drainage below the post to help extend its life. Cross pieces can then be nailed to the posts.


Large rock to protect disturbed ground at upstream end of wall
Extend into stable ground
Earth fill
4x4 Posts spaced at 4' (typical)
Eroded stream bank
Place rock (if available) along base of wall
Flow
Earth Fill

TYPICAL TIMBER WALL FOR EROSION CONTROL
(PLAN VIEW)


4x4 post
2x6 or larger lumber
Rock (if available)
1/32" to 1/16" space for drainage
FILL
Existing ground
6" min. below original ground
well compacted earth fill
12" concrete recommended
30" min. into undisturbed ground
4"+ gravel

TYPICAL SECTION THROUGH WALL

NOTES

Posts & lumber should be rot-resistant (Construction grade Cedar, Redwood, Cypress or treated Pine) & sections to be installed below grade or in contact with earth should be Creosote treated.

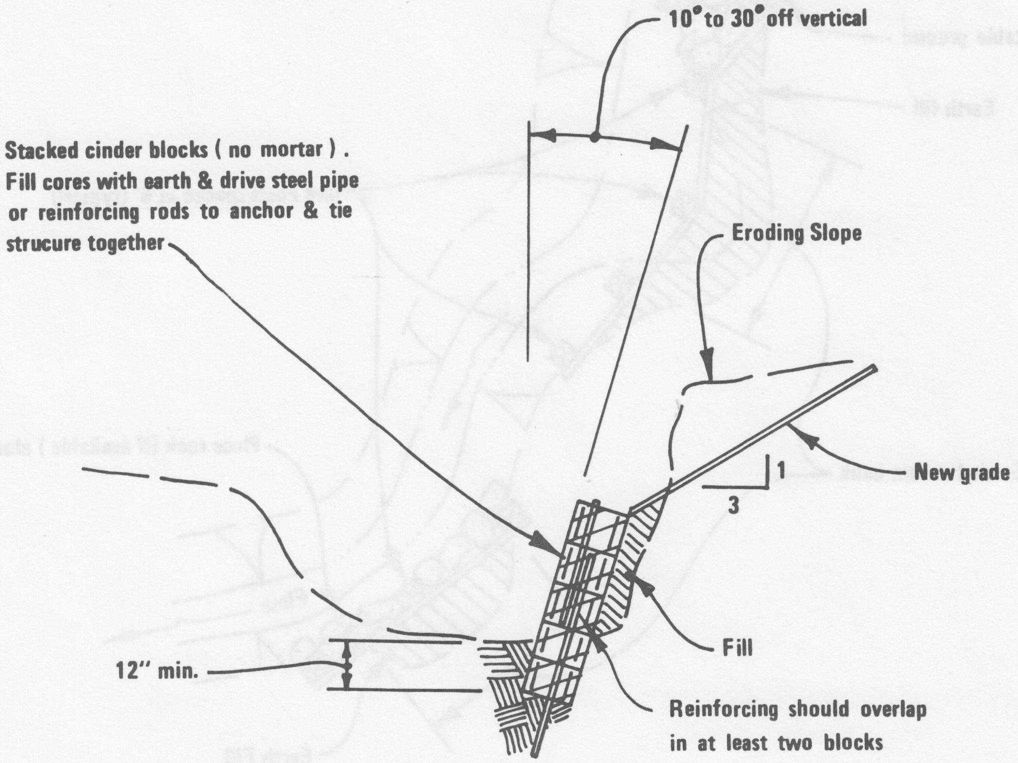
Joints on 2" (horizontal) lumber should be staggered & secured to posts with galvanized nails.

THESE DETAILS DEPICT A TYPICAL CONDITION. THE INSTALLATION MUST BE MODIFIED TO FIT SPECIFIC PROBLEMS AND SITE CONDITIONS.

FIGURE 2.7

Cinder or Masonry Blocks (see figure 2.8)

Cinder or masonry block retaining wall can be constructed using steel pipes or reinforcing rods as anchors. After a rod or pipe is driven into the ground, the block is laid down so that the pipe is running through the holes in the block. As each block is laid, the hole around the pipe or rod should be filled with earth and the earth tamped. This will form a tight but flexible area in which the pipe can take up the stress imposed on the wall from the fill behind it and renders mortaring unnecessary.


10° to 30° off vertical
Stacked cinder blocks (no mortar). Fill cores with earth & drive steel pipe or reinforcing rods to anchor & tie strucure together
Eroding Slope
1
3
New grade
Fill
12" min.
Reinforcing should overlap in at least two blocks

FLEXIBLE MASONRY WALL
(TYPICAL SECTION)

FIGURE 2.8

Other Measures

There are other materials and methods which may prove effective in stabilizing stream banks and may be considered variations of those presented here. Some examples are:

-stacked auto tires partially embedded in stream bank

-railroad ties layed along the stream bank parallel to the direction of flow and anchored to the slope

-chainlink fence laid over the stream bank and secured to slope

-phone poles or relatively uniform delimbed trees placed in "log cabin" type construction

-dumped concrete rubble

-as an immediate, temporary measure, fallen tree limbs piled and secured to slope

We must emphasize that any stream will flood its banks from time to time and this will cause some degree of damage. The normally occurring alternation of erosion and sedimentation will result in natural stream meandering. If the stream channel and its adjacent flood plain are left in a natural state, erosive damage will be minimized. When a flood plain area is disturbed (scrub growth and trees removed in favor of lawn, or grounds over-utilized by children and pets), you may expect erosion problems to increase dramatically.

APPENDIX A

GUIDE TO GOVERNMENT AGENCIES & OFFICES

Government agencies and offices in Montgomery and Prince George's Counties which may be of assistance related to work described in this publication are listed below:

Soil Testing & Planting Recommendations

Montgomery County - County Horticultural Agent, Agricultural Extension Service,
600 South Fredrick Avenue, Gaithersburg, Maryland 20760

Prince George's County - County Horticultural Agent, 15209 Main Street,
Upper Marlboro, Maryland 20870

Information on Homesite Erosion, Sedimentation and Soils

State of Maryland - Soil Conservation Service, Room 522
4321 Hartwick Road, College Park, Maryland 20740

Montgomery County - Montgomery Soil Conservation District,
6110 Executive Boulevard, Rockville, Maryland 20852

Prince George's County - Prince George's County Soil Conservation District,
County Administration Building, Governor Oden Bowie Drive,
Upper Marlboro, Maryland 20870

Permits (Permitting authority varies with local jurisdictions. The agencies listed below should be contacted to identify permit requirements for Montgomery and Prince George's Counties).

Montgomery County Montgomery County Department of Transportation
6110 Executive Boulevard, Rockville, Maryland 20852

Prince George's County - Prince George's County Department of Licenses
and Permits, County Service Building, 5012 Rhode Island Avenue,
Hyattsville, Maryland 20781

To Report Stormwater Hazards, Flooding Due to Storm Drains or Sedimentation Problems

Montgomery County (Stormwater hazards & storm drains)
Department of Transportation, 6110 Executive Boulevard,
Rockville, Maryland 20852

(Sedimentation) Sediment Control, Department of Environmental Protection
6110 Executive Boulevard, Rockville, Maryland 20852

Prince George's County (Stormwater hazards & storm drains)
Stormwater Management Planning Section
Washington Suburban Sanitary Commission, 4017 Hamilton Street
Hyattsville, Maryland 20781

(Sedimentation) Prince George's County Soil Conservation District
County Administration Building, Governor Oden Bowie Drive
Upper Marlboro, Maryland 20870

APPENDIX B-1

FLOOD INSURANCE -- SEWER BACK-UP INSURANCE

A Public Service Bulletin
Of The
WASHINGTON SUBURBAN SANITARY COMMISSION

In response to the expressed interest of some WSSC customers in Suburban Maryland in obtaining information on the availability of insurance coverage to help protect them against financial loss that may occur as a result of flooding or a back-up of water through sewer drains on their property, the Commission's Claims and Insurance Division has compiled the following summary on this subject --

FLOOD INSURANCE under the National Flood Insurance Program and SEWER BACK-UP COVERAGE as an add-on to a Suburban Maryland resident's Homeowner Insurance Policy can be purchased from any insurance agent licensed to do business in Maryland.

FLOOD INSURANCE

The flood insurance policy essentially provides coverage for DIRECT LOSS BY FLOOD as defined below:

A. A general temporary condition of partial or complete inundation of normally dry land areas from...

1. the overflow of inland or tidal waters;

2. the unusual and rapid accumulation of run-off of surface waters from any source;

3. Mudslide (an example, mudflow), a river or flow of liquid mud proximately caused by flooding as defined in subparagraph A-2 above, or by accumulation of water under the ground.

B. The collapse or subsidence of land along the shore of a lake or other body of water as a result of erosion or undermining caused by waves or currents of water exceeding the anticipated cyclical levels.

The coverage described above is subject to all conditions, definitions, exclusions and provisions contained in the flood insurance policy. A $200 per occurrence deductible is applicable to damage to structure and a $200 per occurrence deductible is applicable to damage to contents.

The estimated current cost, for example, for $35,000 per occurrence structure coverage and $10,000 per occurrence contents coverage under the National Flood Insurance Program for a single family residence is as follows:

LOCATION	*AMOUNT*
37th Street, Brentwood, Maryland	*$60 per year*
Laurel, Maryland	*$123 per year*
40th and Oliver Streets, Hyattsville, Maryland	*$60 per year*
94th and Tuckerman Streets, Seabrook, Maryland	*$123 per year*
Carrollton Parkway, New Carrollton, Maryland	*$123 per year*
Montgomery County, Maryland	*$123 per year*

Continued on Next Page...

APPENDIX B-2

Maximum Obtainable Coverage: Laurel and Montgomery County, Maryland

Residential:	*$35,000 structure* *$10,000 contents*
Commercial:	*$100,000 structure* *$100,000 contents*

Maximum Obtainable Coverage: Prince George's County, Maryland except Laurel

		1st Layer	*2nd Layer*	*Total Coverage*
Single Family	*structure*	*$35,000*	*$150,000*	*$185,000*
	contents	*$10,000*	*$ 50,000*	*$ 60,000*
All Other Residential	*structure*	*$100,000*	*$150,000*	*$250,000*
	contents	*$ 10,000*	*$ 50,000*	*$ 60,000*
Small Business	*structure*	*$100,000*	*$150,000*	*$250,000*
	contents	*$100,000*	*$200,000*	*$300,000*
All Other Business	*structure*	*$100,000*	*$100,000*	*$200,000*
	contents	*$100,000*	*$100,000*	*$200,000*

FOR MORE DETAILED INFORMATION ON THE FEDERAL FLOOD INSURANCE PROGRAM, WRITE:

NATIONAL FLOOD INSURANCE PROGRAM
BOX 34294
BETHESDA, MARYLAND 20034

SEWER BACK-UP INSURANCE

State Law (See Article 48A, Section 478½, of the Annotated Code of Maryland) requires that Sewer Back-Up Coverage must be offered as an optional add-on to a resident's existing Homeowner Insurance Policy. The cost of this coverage is $25 per year, and it provides insurance protection for damages sustained as a result of water backing up through the sewer drain which is not caused by the negligence of the insured (property owner) in excess of $250 per occurrence ($250 "deductible") up to the limits of the policy.

This coverage involves policy provisions and terminology which are somewhat technical. It can be best explained by an insurance agent who is familiar with your current, basic Homeowner's Policy. If you are interested in obtaining complete details on this type of add-on coverage, the WSSC suggests that you consult with your insurance agent on how the coverage might fit your household's specific requirements.

-- THE WASHINGTON SUBURBAN SANITARY COMMISSION

APPENDIX C

VEGETATIVE GROUND COVER

BELOW ARE IDENTIFIED SOME COMMON PLANTS WHICH MAY BE USED TO PROTECT AGAINST EROSION

GRASSES*

	For Maintained Lawn Areas	For Non-Maintained Lawn Areas
SUNNY AREAS	“Kentucky Bluegrass” “Bermudagrass” “Mixtures”	“Kentucky 31” “Tall Fescue” “Kentucky Bluegrass” “Mixtures”
SHADY AREAS	“Kentucky Bluegrass” “Creeping Red Fescue” “Bermudagrass” “Mixtures”	Same as above

OTHER GROUND COVERS

SUNNY AREAS	“Spreading Junipers” “Creeping Thyme”	“Crownvetch” “Birdsfoot Trefoil”
SHADY AREAS	“Pachysandra” “Periwinkle”	Same as above

SHRUBS & TREES
(Generally Suited for all Areas)

SHRUBS	“Junipers” “Memorial Rose” “Rem Red Amur Honeysuckle” “Five Leaf Akebia”
TREES	“Willow” “Bristly Locust” “Birches, (Native)” “Loblolly Pine” “European Black Alder”

**Grass seed and sod are certified as to quality by the State Department of Agriculture. To insure good results use seed and sod certified in your State. (More information on vegetative cover and dry weather gardening can be obtained from “Keeping the Garden Green; A Water Conservation Handbook” available at no cost from the WSSC Public Affairs Office (301-699-4172).*

NOTES

A PUBLIC SERVICE PUBLICATION OF THE

WASHINGTON SUBURBAN SANITARY COMMISSION

STORMWATER MANAGEMENT PLANNING SECTION

Additional copies of this publication can be obtained from:

WSSC PUBLIC AFFAIRS OFFICE

4017 HAMILTON STREET

HYATTSVILLE, MARYLAND 20781

Phone: (301) 699-4172

301 206 8000
3189

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